Space Weather Technical Forecast

Issued on Wednesday, 24 July 2024 at 01:24 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: G1-G2/Minor-Moderate likely with a chance of G3/Strong Geomagnetic Storms 24 Jul. Chance of R1 Radio Blackouts throughout. Ongoing S1 Proton Storm easing by 25 Jul.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity has remained Moderate, with a peak long period M2.4 flare observed at 23/1428 UTC, from the southeast limb, likely from AR3764. There are currently ten sunspot regions on the solar disc. The two prominent spots in the southwest are showing signs of decay. AR3751 continues to fade, now with penumbra only visible around the large leader spot, and nearby AR3761 to the east, has seen a slight overall reduction in size and clarity of penumbra. AR3762 in the southeast is a long but sparsely populated spot, with a complex trailing portion consisting of a delta. There are three spots in the far east of the disk, to the north, AR3763 has been reclassified due to penumbra around the trailing region becoming evident. AR3764 just south of the Suns equator appears to have developed a trailing region and although its classification is simple, bright flux is apparent from this region. AR3765 to the south has been recently numbered but appears simple. All remaining regions are small or simple.

There were three CMEs observed in coronagraph imagery in the past 24 hours. The first was a full halo CME from the far-side of the Sun around 23/0030 UTC, which produced the current and on-going minor (S1) proton storm event. The second was observed at 23/0400 UTC off the southwest limb, associated with C3 flare, which has been analysed as a likely miss ahead of Earth arriving at 1AU on 26 Jul. The final CME was from the southwest limb, associated with the M2.4 flare near AR3764 at 23/1430 UTC. This gave a wide and moderately fast CME, perhaps with low confidence of glancing impacts at Earth possible on or around 26 Jul.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by ACE at L1, was at mostly background conditions until a weak CME (thought to be from 19 Jul) arrived around 23/1950 UTC. Speeds remained slow throughout, but jumped from 250 km/s to around 320 km/s at 23/1950 UTC. Density was mostly weak but became moderate from 23/2950 UTC peaking at around 10ppcc. The interplanetary magnetic field (IMF), Bt, was weak, becoming Moderate to Strong after 23/1950 UTC, with a peak of 19nT. The important north-south component, Bz, was almost entirely positive, especially after 23/1950 UTC where it peaked at +12nT. The phi angle was mostly away from the Sun (positive), but bacme negative (Toward the Sun) after 23/2120 UTC. The net result of the above solar wind measures was for mostly Quiet (Kp 0-2) geomagnetic indices, with an Unsettled (Kp3) interval observed 23/1800-2100UTC.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 showed a rapid rise in proton levels from 22/0100 UTC due to a large full halo CME from the far-side of the Sun, which resulted in both the 10MeV and 100MeV threshold being reached. The S1 event is currently on-going. High energy electron flux (greater than 2MeV) observed at GOES16 was at Normal Background. The 24-hour fluence was well below Active, with 1.25e6 integrated pfu observed at 24/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate activity is Likely throughout. While Ex-AR3744 has now departed the

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disc, its loss is in some way compensated for by the flaring into life of AR3762 in the southeastern disc.

Solar Wind /Geomagnetic Activity: No coronal holes or their fast winds feature in the forecast period. Earth is currently experiencing a rather slow and weak CME. Two further CMEs are expected in the period. The first and most notable, is expected to arrive at Earth during day 1 (24 July), most likely during the first part of the day. Speeds may reach enhanced or strong, around 500-700 km/s during this event. The second was a wide a moderately fast CME, with low confidence of glancing impacts at Earth on or around 26 Jul.

Geomagnetic activity will likely become enhanced day 1 (24 Jul) with G1-G2/Minor-Moderate storms likely and a chance of G3/Strong storms. Geomagnetic activity should begin to wane into day 2 (25 Jul), with Quiet conditions likely. There is a slight chance of G1 Minor Storms should the CME from 23 Jul arrive on day 3 (26 Jul).

Energetic Particles / Solar Radiation: High energy proton flux should gradually decline to below the current S1/Minor Storm level by day 2 (25 July), with a Slight Chance of rising above the S1/Minor Storm threshold in response to any notable flares from day 2 (25 Jul) onward.

High energy electron flux is expected to remain at Normal Background levels initially, however confidence decreases due to given inbound CMEs. There is a possible rising Slight Chance of Active later in the period once geomagnetic activity wanes.

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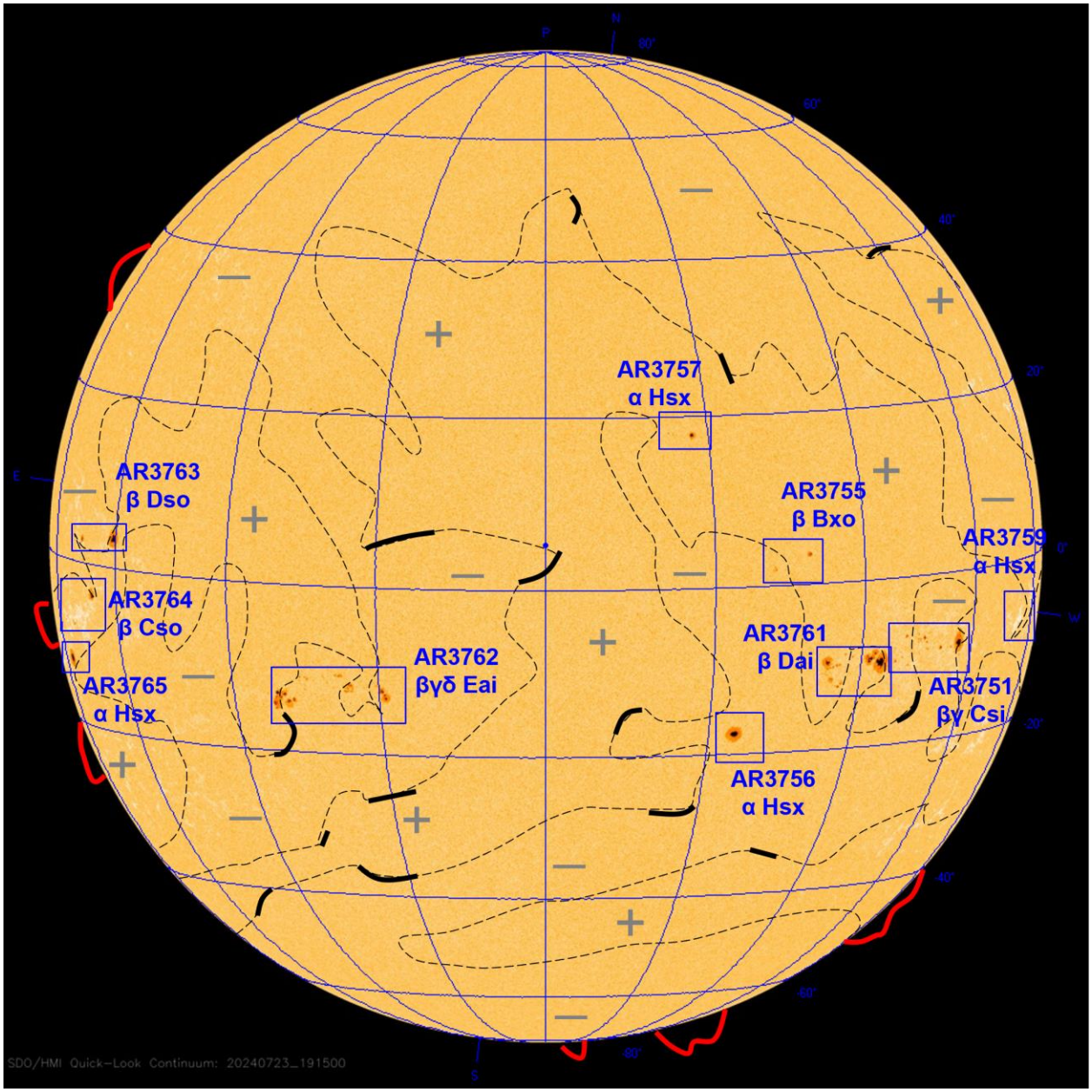
Figure 1. Solar Analysis Valid 23/1915 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

No coronal holes or their fast winds feature in the forecast period. Earth is currently experiencing a rather slow and weak CME, believed to be that from 19 July. There are up to two further CMEs expected in the period.

The first, and most notable CME, was from a filament lift-off was observed at 21/1630 UTC. The ejecta was soon followed by a full halo CME on coronagraph imagery. This is expected to arrive at Earth during day 1 (24 July), most likely during the first part of the day. Speeds may reach enhanced or strong, around 500-700 km/s during this event.

The second CME was from a long period M2.4 flare close to the southeast limb near AR3764 at 23/1430 UTC. This gave a wide and moderately fast CME, perhaps with low confidence of glancing impacts at Earth possible on or around 26 Jul.

Geomagnetic activity will likely become enhanced day 1 (24 Jul) with G1-G2/Minor-Moderate storms likely and a chance of G3/Strong storms. Geomagnetic activity should begin to wane into day 2 (25 Jul), with Quiet conditions likely. There is a slight chance of G1 Minor Storms should the CME from 23 Jul arrive on day 3 (26 Jul).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	70	10	20	5
Strong	G3	No	30	1	1	1
Severe	G4	No	5	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
21/1629	Full	Filament lift-off	NE	1050 km/s	24/0300 UTC +/- 9 hours	Likely
23/2224	Partial	M2.4	SE	560 km/s	26/1500 +/- 12 hours	Low confidence due to location. Shock most probable.

Figure 2: MOSWOC ENLIL

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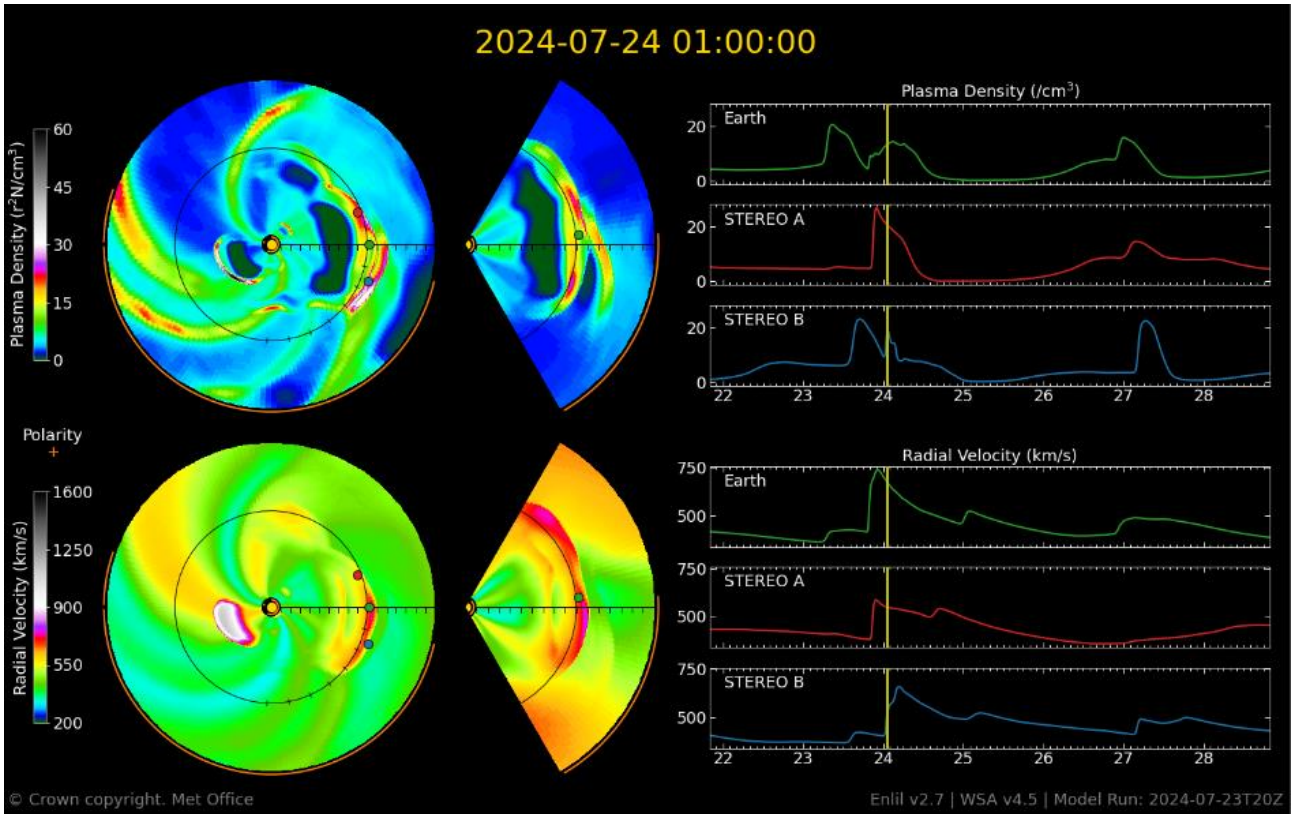

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Radio Blackouts - X-Ray Flares:

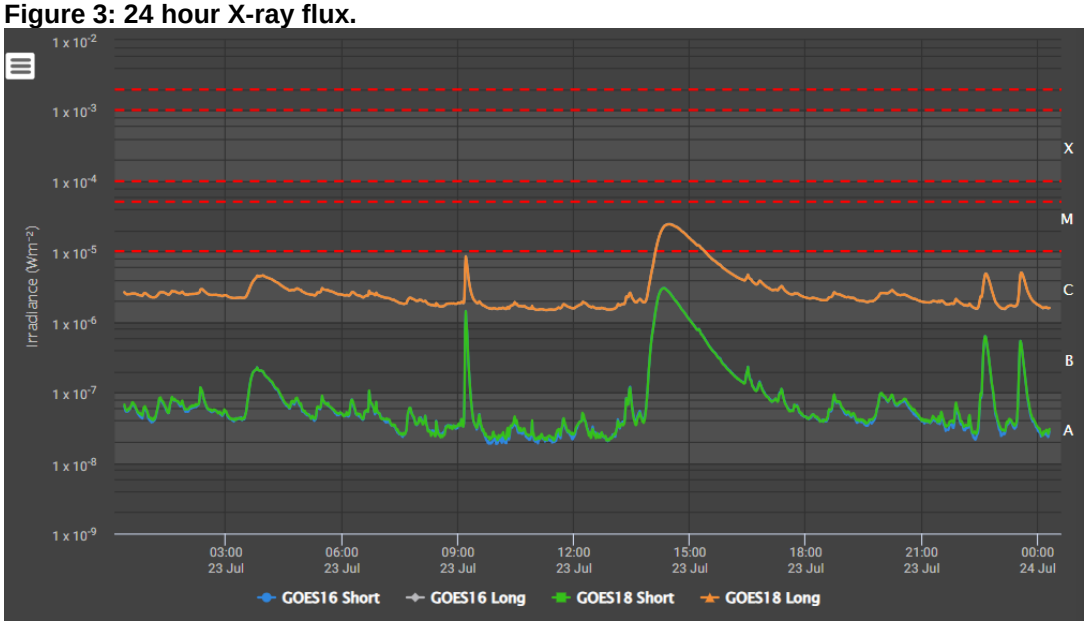
Activity has remained Moderate, with a peak long period M2.4 flare observed at 23/1428 UTC, from the southeast limb, likely from AR3764.

There are currently ten sunspot regions on the solar disc. The two prominent spots in the southwest are showing signs of decay. AR3751 continues to fade, now with penumbra only visible around the large leader spot, and nearby AR3761 to the east, has seen a slight overall reduction in size and clarity of penumbra. AR3762 in the southeast is a long but sparsely populated spot, with a complex trailing portion consisting of a delta. There are three spots in the far east of the disk, to the north, AR3763 has been reclassified due to penumbra around the trailing region becoming evident. AR3764 just south of the Suns equator appears to have developed a trailing region and although its classification is simple, bright flux is apparent from this region. AR3765 to the south has been recently numbered but appears simple. All remaining regions are small or simple.

Activity is expected to be Low to Moderate with a chance of further M-class flares. This risk likely remaining same through the period due to a likely near equilibrium of off-going and oncoming spots from the visible disk.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	50	50	50	50
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: 24 hour X-ray flux.



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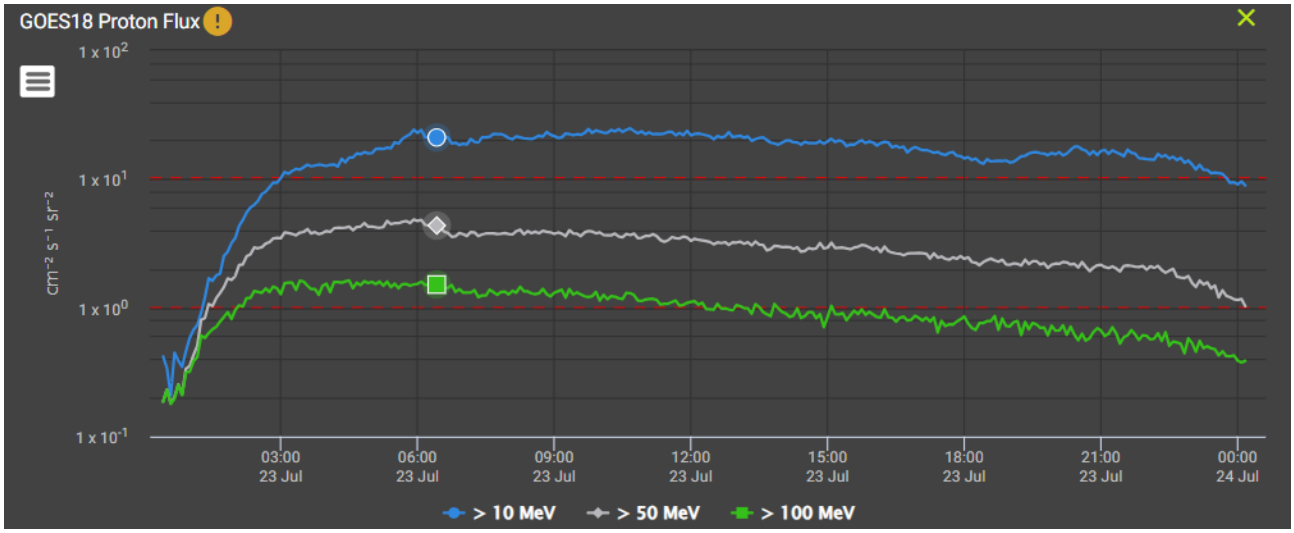
Solar Radiation Storms - (High Energy Protons):

GOES18 proton flux showed a rapid rise from 23/0100UTC with the 10MeV and 100MeV threshold being reached. This was in response to a very large full halo CME, which occurred on the far-side of the Sun. The S1 Minor storm is currently on-going, with the 100MeV below the 1pfu threshold, although the 10MeV remains above the S1 threshold, on a gradual decline, perhaps falling below the threshold later on 24 Jul. The remainder of the period, the risk of proton storms will fall back to raw probabilities given the spots on the disk.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	Yes	90	20	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: 24 hour proton flux



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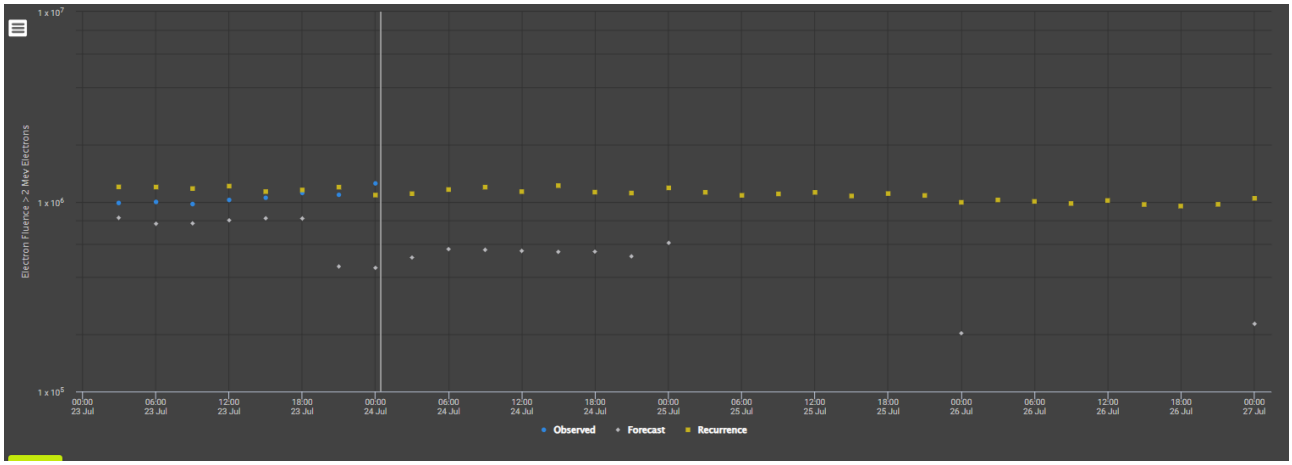
High Energy Electrons Event (≥ 2MeV):

The high energy electron flux as observed by GOES16 is currently at Normal Background and is expected to persist at this level initially. Persistence methods and MOSWOC REFM are not expected to offer a useful steer to eventual fluence levels in the period, owing to the dominance of CMEs in the forecast. On balance, confidence decreases sharply through the period, with a possible rising Slight Chance of Active later in the period once geomagnetic activity wanes.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	10	15	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5:MOSWOC RERM integrated flux/fluence forecast/observations/recurrence.



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